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Time and Demographics in Recreation Demand Models

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TIME AND DEMOGRAPHICS IN RECREATION DEMAND MODELS

Introduction and Problem Statement

Time is an important component in the production of an activity, such as a recreational trip. On the other hand, demographic characteristics of an individual also dictate the nature and level of consumption of a commodity. No recreation demand study has yet been conducted that uses time cost, and at the same time socio-psychological factors as slope and intercept shifters of the recreation demand curve. In this paper we incorporate time and (various) demographic factors [as slope and intercept shifters] in the Travel Cost Demand Model, and estimate the parameters of the recreation demand model, with subsequent welfare measures.

Recent studies have used numerous procedures in accounting for the time cost in recreation demand analysis. The most common method has been to value time as a percentage of the wage rate, using the travel cost model (TCM) of the form:

$$(1) \qquad Z_j = f(P_j + k\, t_j v_j)$$

where, Z_j = number of recreational trips; P_j = per trip expenses per person; t_j = round trip time, and v_j = average hourly income (or wage rate)

Traditionally, k has been "arbitrarily" chosen as a constant, usually in the range of .25 to .50. This arbitrary assignment of recreational value of time is based on empirical estimates of the value of travel time to work (Dewees, 1979), but it has been used in various recreation demand estimation (e.g., Smith, et al., 1983, Hushak, 1985). However, it is not obvious that the value of commuting time should be identical to the value of recreational travel time.

Further, use of demographic variables in recreation demand model is restricted to the study of Kealy & Bishop (KB) and Jeng & Hushak (JH). However, KB used demographic variables as intercept shifters, while JH used demographic variables without the 'time cost' consideration. In this study, we hypothesize and show by steps, that the use of time cost variable improves the explanatory power of the basic travel cost model, and that the incorporation of demographic variables (as slope and intercept shifters) further enhances the explanatory power of the travel cost demand model. We use the likelihood ratio test to achieve this objective, and later show, how welfare measures can be affected if the time and demographic variables are not properly incorporated in the recreation demand model.

Theoretical Model

For recreational demand analysis, the conceptual basis is consistent with that of utility maximization (McConnell, 1975; Smith et.al., 1983; Bockstael et.al., 1987). For a vector of produced activities, $Z = Z_1, Z_2, \ldots\ldots Z_n$, the utility function can be written as:

$$U = U(Z)$$

and the utility maximization problem is of the form:

Max. $U(Z)$ s.t. $I = \sum_{i=1}^{m}\sum_{j=1}^{n} P_i a_{ij} Z_j + w\sum_{j=1}^{n} b_j Z_j$

where, $I =$ Full Income; $P_i =$ Price of ith market good; $X_{ij} = a_{ij} Z_j =$ Quantity of ith market good used to produce Z_j ; $T_j = b_j Z_j =$ Amount of time required to produce Z_j ; and $w =$ wage rate.

Solving this maximization problem, we derive the demand for recreational activity j :

(2) $Z_j = Z_j[I, (\Sigma P_i a_{ij} + w b_j), S_j]$

where, $\Sigma P_i a_{ij} =$ total cost of market goods used for activity j; $w b_j =$ time cost for activity j; $S_j =$ socio-demographic factors.

In determining the value of time for a recreation trip, the McConnell & Strand model considered round trip time cost as explaining the variation in the number of trips. and allowed the sample to determine the value of k endogeneously. The basic specification of the McConnell and Strand (MS) model is of the form:

$$Z_j = \beta_0 + \beta_1(P_j + k\, t_j\, v_j) + \beta_3\, I_j + u_j$$

This can also be specified as:

(3) $Z_j = \beta_0 + \beta_1 P_j + \beta_2\, t_j v_j + \beta_3 I_j + u_j$

where, $\beta_2 = \beta_1 k$

Here k is interpreted as the value of recreation time as a proportion of individual's hourly income.

Pollak and Wales, and Lewbel suggest that demographics are part of the household production technology. Further, the Gorman (1976) specification of a modified demand model indicates a demand function whose slopes and intercepts are affected by the utility generating demographic variables. Thus, the Gorman specification of the MS model can be written as:

$$(4) \qquad Z_j = \beta_0 + \beta_1 P_j + \beta_2 MT_j + \beta_3 I_j + \sum_{k=4}^{8} \beta_k P_j \left(\sum_{i=1}^{3} d_{ij} + f_j\right)$$

$$+ \sum_{k=9}^{12} \beta_k I_j \left(\sum_{i=1}^{3} d_{ij} + f_j\right) + \; + \sum_{k=13}^{16} \beta_k MT_j \left(\sum_{i=1}^{3} d_{ij} + f_j\right)$$

$$+ \sum_{k=17}^{20} \beta_k \left(\sum_{i=1}^{3} d_{ij} + f_j\right) + \; + \sum_{k=21}^{23} \beta_k \left(\sum_{i=1}^{3} d^2_{ij} + f^2_j\right) + \epsilon_j$$

where, $f_j =$ frequency of participation in fishing activity, $d_i =$ ith demographic variable (say i=3), $MT = t_j v_j$, $\epsilon_j =$ error term

DATA, ANALYSIS, AND RESULTS

There has been no prior study of the behavior of charter customers on Ohio's portion of Lake Erie. In order to estimate the recreational demand for Ohio's Lake Erie charterfishing [1] customers, primary data has been collected from the charter customers by mail survey for the 1986 charterfishing season. We collected the listings of charter customers from 369 of Ohio's 707 registered charter captains. We mailed 849 questionnaires to the charter customers and received 256 usable responses providing charterfishing trip information.

Variables used in this study are defined and specified below following the specification of various empirical models. It is argued here that economists generally accept the fact that economic theory provides a guiding light in establishing the empirical model. However, theory itself is quite permissive with respect to the exact specification of the econometric model, including its functional form. Regarding the use of various functional forms: linear, double log and semilogs are commonly used functional forms in recreation demand analysis. In this study a linear formulation of a demand function is used.

Model 1 (M1) refers to the restricted model where the dependent variable (number of recreation trips) is run without any explanatory variable, such that:

$$(M1) \qquad Z_j = \beta_0$$

Model 2 (M2) refers to the basic travel cost model [without any time cost consideration], where travel related vehicle costs and income appear as the explanatory variables:

$$(M2) \qquad Z_j = \beta_0 + \beta_1 P_j + \beta_2 I + \epsilon_j$$

Following equation 3, model 3 refers to the recreation demand model of MS (M3), where the time cost is considered in addition to the travel cost and income [wealth] variable considerations. Thus, the empirical formulation of the MS model (M3) is:

$$(M3) \qquad Z_j = \beta_0 + \beta_1 P_j + \beta_2 MT_j + \beta_3 I_j + \epsilon_j$$

Here, $\beta_2 = \beta_1 k$ and $MT_j = t_j v_j$. Instead of traditional model approaches to arbtrarily restricting k, where $\hat{k} = \frac{\hat{\beta}_2}{\hat{\beta}_1}$ to be in the range of $0 < k < 1$, MS allowed the sample observations to determine the value of k. The MS expectation is that the value of $\hat{k}$ lies between 0 and 1, which is based on their expected sign and relationship of $\hat{\beta}_1 < \hat{\beta}_2 < 0$. They assumed that there exists some positive value of recreation time, i. e., $k>0$, and that the value of recreation time is not high enough to be equal to individuals hourly income for k to be equal to 1.

However, this MS specification is somewhat incomplete. Pollak and Wales found that the household demand functions are greatly influenced by the demographic variables. Following the Gorman specification (1976) of the modified demand function, the MS specification can be transformed into the full Gorman specification of the MS (GMS) model (M4), i.e., equation 4 can be operationalised by the following specification:

$$Z_j = \beta_0 + \beta_1 P + \beta_2 MT + \beta_3 I + \beta_4 FRQ + \beta_5 DEP + \beta_6 AGE + \beta_7 ED + \beta_8 PRF +$$

$$+ \beta_9 INF + \beta_{10} MTF + \beta_{11} PRD + \beta_{12} IND + \beta_{13} MTD + \beta_{14} PRG + \beta_{15} ING$$

$$+ \beta_{16} MTG + \beta_{17} PRE + \beta_{18} INE + \beta_{19} MTE + \beta_{20} FF + \beta_{21} DD$$

$$(M\,4) \qquad + \beta_{22} AGG + \beta_{23} EE + \epsilon_j$$

In the next step, a specification search was conducted on the Gorman specification of the MS model (M4) with respect to significance levels, and variables were screened using the t-statistics, subject to the condition that the travel cost, time cost, and income variables appear in the equation. Leamer asserts that the theory does not say much in detail of a specific phenomenon. However, real life observations [i.e., data] contain valuable information. Through specification search we can extract a specific, yet valuable empirical model that is also consistent with the proposed economic theory. Fisher and Shell add, "it is desirable to confront the relationship of any theory with as much data as possible" because such "observable information" is useful (p.14). Further, when a maintained hypothesis, (i.e., 'a specification') is nullified, it is "replaced" by an alternative/competing hypothesis- resulting in a new maintained hypothesis/specification (Theil, 1961). Thus, we argued that a specification search is valid, and scientific, as long as it introduces a maintained hypothesis that can be contradicted, resulting into consequences that are testable and falsifiable.

Our specification search led to the preferred equation (M5) of the form:

$$(M5) \quad Z_j = \beta_0 + \beta_1 P + \beta_2 MT + \beta_3 I + \beta_4 FRQ + \beta_5 DEP + \beta_6 ED + \beta_7 PRF$$

$$+ \beta_8 INF + \beta_9 PRD + \beta_{10} IND + \beta_{11} MTD + \beta_{12} FF + \beta_{13} DD + \epsilon_j$$

Where. Z = Number of charterfishing trips to Ohio's Lake Erie; P = (Pri)/(Avg. charterfishing party size) where, $Pri = \$0.30 * Dist + (2 * Dist)/(Avg.mpg)$, assuming Price (gas) = $1.00/gal. Dist= Distance traveled from home to the fishing zone; Y = Midpoint of Gross Household Income category; MT = 2*HRINC*TIME: where, HRINC (i.e., hourly income) = annual income/2080, TIME = Dist/50mph, FRQ = Average frequency of fishing at different age bracket (Scale:1 to 5) where, 1 = Did not fish, . . . , 5 = Fished at least once a week; AGE = Age of the angler; DEP = Number of dependents living at home with the angler; ED = Education level of the angler(years of schooling); PRF = P*FRQ; INF = I*FRQ; MTF = MT*FRQ; PRG = P*AGE; ING = I*AGE; MTG = MT*AGE; PRD = P*DEP; IND = I*DEP; MTD = MT*DEP; PRE = P*ED; INE = I*ED; MTE = MT*ED; FF = FRQ*FRQ; AGG = AGE*AGE; DD = DEP*DEP; EE = ED*ED:

Most recent recreation studies use "user only" data for recreational demand analysis (Kealy and Bishop, 1986; Smith et. al., 1983). Such user only data are truncated for the dependent variable (say, Z/Z>0). If ordinary least squares procedure is used to estimate such demand for truncated data, "truncation bias" is introduced [Bockstael et.al., (1987), Kealy & Bishop]. This in turn leads to biased parameter estimates. To alleviate this problem, the conditional maximum likelihood method is appropriate, for it provides a consistent estimator of recreational demand model. Our sample of charterfishing recreationists is also characterised by user only data, truncated for the dependent variable. Thus, the log likelihood function for this model can be written as:

$$(5)\quad Log\ L = -\ N\ Log\,[\,(\,2\pi)^{1/2}\sigma] - 1/2\ \Sigma\,[\,(Z_j - \beta' \ P_j)/\sigma]^2\ - \Sigma\ \log\ \Phi[\,(0 - \alpha\ P_j)/\sigma\ ]$$

Here, N is the number of observations, σ is the standard error, Z_j is the truncated dependent variable (number of recreation trips), β is the vector of parameters for equation M1 through M5, P'_j is the vector of exogeneous variable, Φ is the cumulative standard normal distribution function. Parameters of the demand equation for Z_j can be estimated by simply maximizing the above log likelihood function.

Table 1 shows the values of the likelihood function for different models, and various likelihood ratio (LR) values as they are compared with relevant table value of the χ^2. LR-test basically helps compare the explanatory powers of different models, and is calculated by:

$$(6)\qquad LR = 2\,[\,\log(\hat{\theta}) - \log(\bar{\theta})\,]\ \sim\ \chi^2(g)$$

Where, θ = Unrestricted estimate of the population vector, $\bar{\theta}$ = restricted estimate of the population, g = number of restrictions imposed by the null hypothesis.

For example, the value LR(M2) = 5.53 in table 1 is calculated by using equation 6 where the TCM (M2) is treated as the restricted model while the MS model (M3) is unrestricted. And the number of restriction(s) in this case is 1 (i.e., g=1). From χ^2 table we find that $\chi^2_{g,.05} = \chi^2_{1,.05} = 3.84$. Since LR(M2) = 5.53 $> \chi^2_{1,.05} (= 3.84)$, we conclude that the MS model performs better than the basic TCM. Also from table 1, results of the LR-tests further show that the GMS model performs better than the TCM, as well as the MS model. On the other hand, the Preferred model also performs better than the TCM, and the MS model. However, when the insignificant variables were deleted from the GMS model resulting the Preferred model, the LR-test show that the GMS model is not found to be significantly better than the Preferred model. Nevertheless, the Preferred model does contain the time cost variable, and the socio-psychological variables, in addition to the vehicle related travel cost and income variables. These findings clearly suggest that the inclusion of time cost, and the demographic variables does significantly improve the explanatory power of the travel cost recreation demand model.

Table 2 shows the estimates of elasticities, k-values and Consumer's Surplus measures. For most of the models, the price elasticity is found to be greater than one. This indicates that there 'may be' alternative/substitute commodity for this recreation activity. Such substitutes can be fishing trips to local sites, other Great Lakes sites, marine sites, and/or, noncharterfishing trips, or may be some other form of recreation activity [such as going to baseball/basketball games in spring/summer, and to football/ baseball games in fall). Besides, we also find that the estimated income elasticities are greater than 1 for most of the models. This clearly suggests that the charterfishing recreation is a luxury good. Also, the k-values for the models ranged from .09 to .62. Such variation in the value of k vis a vis the value of human time for recreation may be for various specifications of the recreation demand model. More importantly, such variations indicate that the socio-psychological factors are very sensitive in changing the slope and intercept of the recreation demand curve, as observed under alternative (socio-psychological) specifications.

Welfare Estimation

For our linear specification of the recreation demand model the estimates of the consumer's surplus are calculated by using the formula derived by Bockstael et.al., (1984). They show that when the demand function is linear, and all the parameters of the demand function $Z = \alpha + \beta P$ are correctly known, the CS can be calculated by using the formula: $CS = -\dfrac{\overline{Z}^2}{2\beta}$.

For our charterfishing customer sample, the average Willingness To Pay (WTP) at the mean number of trips varies from $33.51 for the basic TCM to $281.78 for the GMS model, where variations in WTP result from variations on consumer surplus, and the value of k. Further, the value of CS estimates indicate that with the inclusion of time cost in the TCM (i. e., the MS model), the CS measure increases by over 2-times, and over 7-times when the full Gorman specification is used. These estimates also show that the socio-demographics and the time variables are critical factors affecting the economic value of recreation demand. This also means that if the time variable, or the socio-psychological factors are ignored, the CS measures would certainly be an underestimated one. These findings suggests that we need to incorporate time costs variable as well as the socio-psychological factors in modelling a conceptually sound recreation demand model.

Conclusions

This study focused on estimating the Lake Erie recreation demand for charterfishing using travel cost, time cost and socio-demographic factors as intercept and slope shifters of the recreation demand curve. Recent model of McConnell and Strand provided the basis of the recreation time cost specification, while the demographic demand study of Pollak and Wales provided the guidence in socio-psychological specifications of the Gorman model. Our empirical findings show that the recreation demand model having the time cost variable along with the demographic variables (as slope and intercept shifters) perform better than the basic TCM, and the TCM with the time cost consideration. Further, our results also suggest that exclusion of each of these time cost and demographic factors would lead to underestimation of the consumer surplus measures.

FOOTNOTE

1. A charterfishing is a fishing trip where a recreationist or a party of recreationists rent the services of a charter captain and his boat for the purpose of fishing.

Table 1. Values of Likelihood Function, Likelihood Ratio and χ^2 at $\alpha = .05$

Models	Value of the Likelihood Function	LR(M1)[a]	$\chi^2_{g,.05}$	LR(M2)	$\chi^2_{g,.05}$	LR(M3)	$\chi^2_{g,.05}$	LR(M5)	$\chi^2_{g,.05}$
M1	-569.95	-	–	-		-		-	
M2	-561.48	16.94*	5.99	-	–	-		-	
M3	-558.85	22.21*	7.82	5.53*	3.84	-		-	
M4	-537.41	65.10*	35.17	48.15*	32.15	42.89*	31.41	8.84	18.31
M5	-541.41	30.55*	22.36	39.31*	19.68	34.04*	18.31		

a. Likelihood Ratio test against the restricted model M(.)

* Significant at the 5% level.

Table 2. Elasticities, k-values and Consumer's Surplus Estimates for the Lake Erie Charterfishing Recreation Demand Equations.

Models	Elasticities		k-value	Avg. WTP	CS
	Price	Income		$/person/yr.	$/person/yr.
M1	–	–	–	–	–
M2	-5.67	.58	-	33.51	2.72
M3	-6.75	2.75	.13	85.67	5.91
M4	-6.71	5.79	.62	281.78	19.54
M5	-5.90	5.60	.19	119.17	9.31

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